aircraft, such as sailplanes, using mechanical means not incorporated in the aircraft itself.

The innovation consists of an elastic cord (for propulsive force), a tether extension (optional, for additional height), and the kite (instrumentation optional). Operation of the system is accomplished by fixing the elastic cord to ground (or equivalent), attaching the cord with/or without a tether extension to the kite, tensioning the system to store energy, and releasing the kite. The kite will climb until energy is dissipated.

This work was done by Geoffrey Bland and Ted Miles of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16004-1

Supercritical CO_2 Cleaning System for Planetary Protection and Contamination Control Applications

This system can be used for precision cleaning in optical and semiconductor applications.

NASA's Jet Propulsion Laboratory, Pasadena, California

Current spacecraft-compatible cleaning protocols involve a vapor degreaser, liquid sonication, and alcohol wiping. These methods are not very effective in removing live and dead microbes from spacecraft piece parts of slightly complicated geometry, such as tubing and loosely fitted nuts and bolts. Contamination control practices are traditionally focused on cleaning and monitoring of particulate and oily residual. Vapor degreaser and outgassing bakeout have not been proven to be effective in removing some less volatile, hydrophilic biomolecules of significant relevance to life detection.

A precision cleaning technology was developed using supercritical CO_2 (SCC). SCC is used as both solvent and carrier for removing organic and particulate contaminants. Supercritical fluid, like SCC, is characterized by physical and thermal properties that are between those of the pure liquid and gas phases. The fluid density is a function of the temperature and pressure. Its solvating power can be adjusted by changing the pressure or temperature, or adding a secondary solvent such as alcohol or water.

Unlike a regular organic solvent, SCC has higher diffusivities, lower viscosity, and lower surface tension. It readily penetrates porous and fibrous solids and can reach hard-to-reach surfaces of the parts with complex geometry. Importantly, the CO_2 solvent does not leave any residue.

The results using this new cleaning device demonstrated that both supercritical CO_2 with 5% water as a co-solvent can achieve cleanliness levels of 0.01 mg/cm^2 or less for contaminants of a wide range of hydrophobicities. Experiments under the same conditions using compressed Martian air mix, which consists of 95% CO_2, produced similar cleaning effectiveness on the hydrophobic compounds.

The main components of the SCC cleaning system are a high-pressure cleaning vessel, a boil-off vessel located downstream from the cleaning vessel, a syringe-type high-pressure pump, a heat exchanger, and a back pressure regulator (BPR).

After soaking the parts to be cleaned in the clean vessel for a period, the CO_2 with contaminants is flushed out of the cleaning vessel using fresh CO_2 in a first-in-first-out (FIFO) method. The contaminants are either precipitating out in the boil-off container or being trapped in a filter subsystem. The parts to be cleaned are secured in a basket inside and can be rotated up to 1,400 rpm by a magnetic drive. The fluid flows within the vessel generate tangential forces on the parts' surfaces, enhancing the cleaning effectiveness and shortening the soaking time.

During the FIFO flushing, the pump subsystem pushes fresh CO_2 into the cleaning vessel at a constant flow rate between 0.01 and 200 mL/min, while the BPR regulates the pressure in the cleaning vessel to within 0.1 bar by controlling the needle position in an outlet valve.

The fresh CO_2 gas flows through the heat exchanger at a given temperature before entering the cleaning vessel. A platinum resistance thermometer (PRT) reads the cleaning vessel interior temperature that can be controlled to within 0.1 K. As a result, cleaning vessel temperature remains constant during the FIFO flushing. There is no change in solvent power during FIFO flushing since both temperature and pressure inside the cleaning vessel remain unchanged, thus minimizing contaminants left behind. During decompression, both temperature and pressure are strictly controlled to prevent bubbles from generating in the cleaning vessel that could stir up the contaminants that sank to the bottom by gravity.

This work was done by Ying Lin, Fang Zhong, David C. Aveline, and Mark S. Anderson of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47414

Design and Performance of a Wideband Radio Telescope

NASA's Jet Propulsion Laboratory, Pasadena, California

The Goldstone Apple Valley Radio Telescope (GAVRT) is an outreach project, a partnership involving NASA's Jet Propulsion Laboratory (JPL), the Lewis Center for Educational Research (LCER), and the Apple Valley Unified School District near the NASA Goldstone deep space communication complex. This educational program currently uses a 34-meter antenna, DSS12, at Goldstone for classroom radio astronomy observations via the Internet. The current program utilizes DSS12 in two narrow frequency bands around S-band (2.3 GHz) and X-band (8.45 GHz), and is used by a training program involving a large number of secondary school teachers and their classrooms. To expand the program, a joint JPL/LCER project was started in mid-2006 to retrofit an additional existing 34-meter beam-waveguide antenna, DSS28, with wideband feeds and receivers to cover the 0.5-to-14-GHz frequency bands.

The DSS28 antenna has a 34-meter diameter main reflector, a 2.54-meter subreflector, and a set of beam waveguide mirrors surrounded by a 2.43-meter tube. The antenna was designed for high power and a narrow frequency band around 7.2 GHz. The performance at the low end of the frequency band desired for the educational program would be extremely poor if the beam waveguide system was used as part of the feed system. Consequently, the 34-meter antenna was retrofitted with a tertiary offset mirror placed at the vertex of the main reflector. The tertiary mirror can be rotated to use two wideband feeds that cover the 0.5-to-14-GHz band.

The earlier designs for both GAVRT and the DSN only used narrow band feeds and consequently, only covered a small part of the S- and X-band frequencies. By using both a wideband feed and wideband amplifiers, the entire band from 0.5 to 14 GHz is covered, expanding significantly the science activities that can be studied using this system.

This work was done by Sander Weinreb, William A. Imbriale, Glenn Jones, and Handi Mani of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46668